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Motivations For BYOD: An Investigation Of The Contents Of A 21st Century School Bag

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MOTIVATIONS FOR BYOD: AN INVESTIGATION OF THE CONTENTS OF A 21ST CENTURY SCHOOL BAG

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Abstract

Bring-Your-Own-Device (BYOD) is an emerging socio-technical phenomenon in both businesses, and increasingly, in schools-where it is being advocated for ICT enabled learning. The later has not, to date, received as much research attention as the former. Despite accelerating adoption, the factors that affect students' use of BYOD are still not well articulated. This research determines those factors that affect secondary school students' use of BYOD. We used a modified version of Taylor and Todd's (1995) decomposed Theory of Planned Behaviour (TPB) to evaluate antecedents to behavioural intention to BYOD. We received 386 responses from 9 New Zealand secondary schools. The results show that students' behavioural intention to use their own device is substantially influenced by their attitude and moderately influenced by their subjective norms and perceived behavioural control.

Keywords: BYOD, Schools, eLearning, Students.

1 Introduction

"Schools can no longer be the last place to catch up to the present"

Lisa Nielson, 2012

In the 21st century classroom, students inhabit a world where they can expect immediate access to information resources at anytime and from anywhere. A new pedagogy has emerged that relies on students having ready access to high speed Internet and reliable access to information resources (Chan et al, 2006, Douglas, 2011). These 21st century learners enjoy choice in both learning style and the technology alternatives that support their learning (Norris & Solway, 2011). These students no longer expect to have to wait for access to a computer or to learn in a predictable classroom context, but instead can choose to use a range of devices and interfaces (Peng, Chou & Chang, 2008). Digital technology has generally been used to extend and deepen the in-class learning environment (John & Sutherland, 2005). Many schools now fully support the use of these devices in ways that enables personalised learning to occur in a manner that alters the traditional dynamic of the classroom away from an "I teach", and moves towards, "we learn", pedagogy. Alongside advances in mobile technology, students can now use their personally owned devices carried in their school bag to enable and customise their learning in a style and at a pace that suits them (Douglas, 2011). However, it is often difficult for school budgets and administration to keep pace with the near-constant technological change. The Bring Your Own Device (BYOD) phenomenon has arisen as a response to this need. The BYOD craze has not been without its controversies. It has been argued that BYOD deepens the digital divide, creates distractions, cyber risks, and unrealistic demands on school infrastructures and teachers' technological knowledge (Neilson, 2013). Despite this, it has been suggested that when managed appropriately, BYOD can offer a powerful learning environment that is engaging, fosters creative thinking, and honours students' own passions and preferences for learning (Neilson, 2013).

2 Theoretical foundation and model development

The BYOD phenomenon is rapidly becoming more accessible, ubiquitous, and affordable. BYOD use is characterised by consumer technology that is: privately owned, wireless and portable. Device choices in the BYOD menu include (but are not confined to) the: laptop, netbook, iPad, tablet computer, iPod-touch, and smartphone. Education commentators recognise that BYOD is still in its infancy (Norris & Soloway, 2011) and is referred to variously as: an initiative, a policy, a program (Ullman, 2011), a vision (Thomson, 2012) and a scheme (Harris, 2012). Based on these definitions, for the purposes of this research, BYOD is defined as: privately owned, wireless and portable electronic technology including but not restricted to laptops, netbooks, tablet computers, Internet capable media players, and smart phones.

Chan et al. (2006) defines one-to-one technology for education as sharing the following six characteristics: *Portability*, being able to take the device to different sites and facilitate movement within a site so that the bounds of the classroom are extended; *Social interactivity*, that is supported via mobile and wireless technologies to enable peer-to-peer communication; *Data exchange*, in both face-to-face interaction and through collaboration; *Customization*, to suit an individual's path of investigation; *Context sensitivity*, that automatically logs and aggregates actions for enabling collaborative filtering systems; and predictive user interfaces; *Connectivity*, that enables a shared environment via a common data network for use by distributed devices.

Increasing education sector public commentary suggested that BYOD was following a typical diffusion of innovations (DoI) pattern, where early adopters and an early majority were playing an important role in determining the current state of BYOD in schools (Norris &

Soloway, 2011, Rogers 2003). This led us to posit the research question: *What factors affect the use, or intention to use, Bring Your Own Devices (BYOD) for 21st century secondary school students in New Zealand?*

Drawing from social psychology; Fishbien and Ajzen's (1975) theory of reasoned action (TRA) is a sound predictor of a wide range of behaviours. The core constructs of TRA are the attitude towards behaviour and the subjective norm. Davis (1989) applied TRA to individual acceptance of technology and developed the widely used technology acceptance model (TAM) for use in the information systems context. Taylor and Todd (1995) defined this further as; the perceptions of internal and external constraints on behaviour. Further studies within information systems have expanded on the core thinking of TRA/TAM/TPB such as Venkatesh et al.'s (2003) Unified Theory of Acceptance and Use of Technology (UTAUT). Adoption models have also been applied to explain e-learning acceptance (Sumak, Hericko & Pusnik, 2011; Lee, 2010).

Acknowledging the differences of the education context, we concur with Straub (2009) who noted the influences of technology in relationships with students and teacher identity are not able to be captured sufficiently with TAM alone. Therefore we selected Taylor and Todd's (1995) decomposed TPB model (D-TPB) to determine those factors that affect students' use of BYOD's. Taylor and Todd (1995) decomposed the subjective norms and perceived behavioural control dimensions into specific belief dimensions that include students' and teachers' influences. They also incorporated additional factors that were not present in TAM, but have been shown to be important determinants of behaviour (Ajzen, 1991).

However, TAM still provided us with two additional beliefs, perceived ease of use and perceived usefulness (Davis, 1989). Perceived ease of use can be used as a measure of intended use of BYOD. Perceived usefulness represents how an individual believes that the technology will enhance their individual performance (Davis, 1989). Adoption literature asserts that perceived usefulness is a good factor for determining an individual's intention to adopt a technology (Davis, 1989; Venkatesh, 2000; Venkatesh & Davis, 2000). Bhattacherjee's (2001) expectation-confirmation model found that perceived usefulness had a positive effect on users' intention to continue IT usage so perceived usefulness was also included as factor.

Fishbein and Ajzen (1975) described subjective norms as a user's behavioural intention to carry out an action. In addition, Hartwick & Barki (1994) asserted that prior studies suggested subjective norms are an important determinant of behavioural intention. As such, subjective norms are hypothesized to be an important element in influencing students' behavioural intention to use their own device. Taylor & Todd (1995) suggested that peers and instructors are also important referent groups in education. The normative beliefs of other students' and instructors' have been found to be influential antecedents of a user's subjective norms (Hartwick and Barki 1994). Further, peer influences, teacher influences, and parent or guardian influences within the context of students' education are also likely to have an effect on their subjective norms. These items provided us with the necessary antecedents for assessing a student's perceived self-efficacy, as well as their perceived ability to control their own device, or to conceptualize their learning autonomy (Liaw, Huang and Chen 2007).

Self-efficacy represents the judgment of a users' ability to perform (Agarwal & Karahanna, 2000; Ajzen, 2002). It is expected that how a student perceives their ability to effectively use their devices in the learning process within a classroom directly impacts their behavioural intent. The stronger the intent toward a particular behaviour the more likely the individual is to perform that behaviour (Venkatesh and Davis, 2000 and Venkatesh et al., 2003). In addition, there are relatively few students who have long term experience using their own devices for facilitated learning in the classroom. So, relying upon their actual behaviour might lead to forming incorrect inferences. As a result of this, behavioural intention was identified as the more appropriate dependant variable (Ajzen, 1991, 2002).

3 Research method

The research model is a modified version of the D-TPB model with the addition of an extra formative indicator of perceived behavioural control as learning autonomy (student's perceived ability to control their own device), (Liaw et al., 2007). Then we divided superior's influence into teachers and parents/guardians to provide additional granularity to the subjective norm construct (Figure 1).

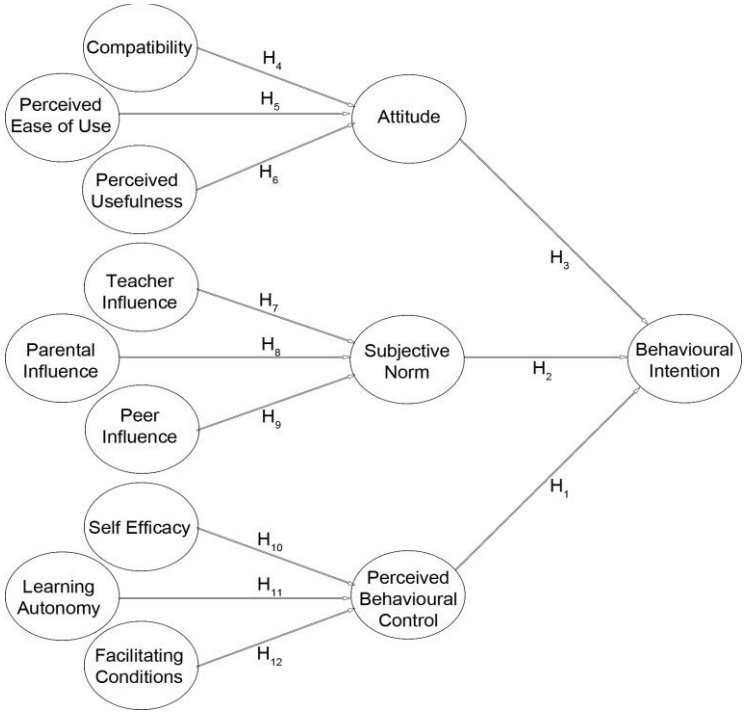


Figure 1 Research model of Behavioral Intention to BYOD by school students.

Based on the research model, the following hypotheses were defined.

H1 Perceived Behavioural Control will have a positive effect on behavioural intention
H2 Subjective Norm will have a positive effect on behavioural intention
H3 Attitude will have a positive effect on behavioural intention
H4 Compatibility will have a positive effect on attitude
H5 Perceived Ease of Use will have a positive effect on attitude
H6 Perceived Usefulness will have a positive effect on attitude
H7 Teacher influence will have a positive effect on subjective norm
H8 Parent/guardian influence will have a positive effect on subjective norm
H9 Peer influence will have a positive effect on subjective norm
H10 Self Efficacy will have a positive effect on perceived behavioural control
H11 Learning Autonomy will have a positive effect on perceived behavioural control
H12 Facilitating conditions will have a positive effect on perceived behavioural control.

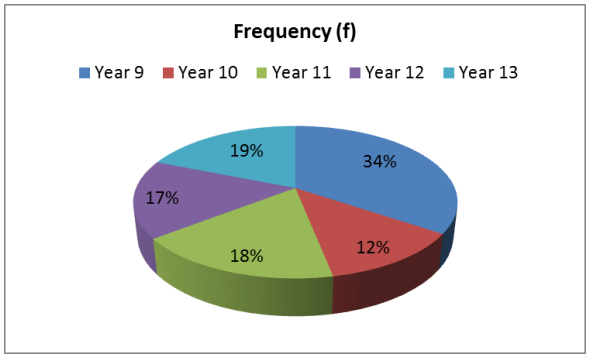
The model was operatonalized based on the items used in D-TPB, modified to suit the BYOD context of the research. The initial questionnaire was reviewed by three academic faculty colleagues in an affinity workshop to validate the content. The questionnaire is attached as Appendix 1. Each item was measured using a five-point Likert scale, with anchors ranging from "Strongly Agree" (1) to "Strongly Disagree" (5). Empirical data was collected from nine secondary schools recruited through established research relationships.

All schools in the sample have sufficient supporting infrastructure in place for effective BYOD use. This allowed us to use intention-to-use as the dependent variable, as there were

no obstacles that would impede actual use. Data was collected via a cross-sectional anonymous web-based voluntary questionnaire that took place between August and October 2012. A total of 386 valid surveys were completed and data analysis was carried out with SPSS v20.0 and SmartPLS 2.0.

4 Results

The gender balance of the sample was: 204 (52.8%) male students and 182 (47.2%) female. On average there was slightly less than 1.8 devices per student; this illustrates that some students use multiple devices whilst learning at school. The spread of student devices was: Smartphone, 101; Laptop, 191; Netbook, 63; iPad, 117; iPod-touch, 107; iPhone, 52; Tablet (non- iPad), 26; Other device, 21.



Students who responded to the questionnaire covered school years 9 (approximate age: 12) to year 13 students (approximate age: 17).

Just over a third (133) of the responses was from the year 9 cohort. This was explained because a large school that participated has implemented a mandatory BYOD program for their current year 9 students (Figure 2).

Figure 2: Frequency by year group

4.1 Assessment of measurement properties

The measurement model was assessed in terms of individual item loadings, reliability of measures, convergent validity and discriminant validity (Gefen, Straub & Boudreau, 2000). The structural model was examined to investigate the strength and direction of the relationships among the theoretical constructs. Bootstrapping was used to determine the confidence intervals of the path coefficients and statistical inference. Table 1 shows the t-statistic for each of the path coefficients. The majority of the calculated t-values are above 2.58 except for SN → BI which is significant at the 5% level.

Hypothesis	Path	Original Sample	Sample Mean	Std. Deviation	Standard Error	t-statistic
H1 - Confirmed	PBC → BI	0.3572	0.358	0.0476	0.0476	7.5001
H2 - Confirmed	SN → BI	0.1064	0.1069	0.0485	0.0485	2.1936
H3 - Confirmed	A → BI	0.4465	0.4453	0.0462	0.0462	9.6721
H4 - Confirmed	C → A	0.4685	0.4683	0.0312	0.0312	14.9989
H5 - Confirmed	PEOU → A	0.4133	0.4148	0.023	0.023	17.9926
H6 - Confirmed	PU → A	0.1733	0.1723	0.0311	0.0311	5.571
H7 - Confirmed	TI → SN	0.1613	0.1658	0.0506	0.0506	3.1886
H8 - Confirmed	PGI → SN	0.3894	0.3881	0.047	0.047	8.2841
H9 - Confirmed	PI → SN	0.341	0.3391	0.0428	0.0428	7.9714
H10 - Confirmed	SE → PBC	0.401	0.3991	0.0559	0.0559	7.1766
H11 - Confirmed	LA → PBC	0.2077	0.2072	0.0614	0.0614	3.3802
H12 - Confirmed	FC → PBC	0.1426	0.1462	0.0524	0.0524	2.719

Table 1 Path Coefficients

In order to measure the internal consistency Cronbach's alpha coefficient and composite reliability was used. All multi-item constructs met the guidelines for composite reliability with a score greater than 0.70 (Hair et al., 2006). Cronbach's alpha coefficient for each construct ranged from 0.608 to 0.885. This met Nunally's (1978) suggestion that 0.7 is a suitable benchmark for modest reliability and that alpha scores between 0.6 and 0.7 are also acceptable (Kline, 1999). As a result only the facilitating conditions item four (FC4) construct required attention. When FC4 was dropped, the alpha score revised to an acceptable level of 0.614. FC4 was problematic because of a slightly higher mean score of 2.45 compared to the other mean scores of 2.07, 2.09, and 1.73. This indicated that students were marginally less worried about their devices getting lost/stolen/broken whilst at school in comparison to other facilitating conditions such as their ability to easily connect to the school's Wi-Fi, compatibility of apps on their device, and their awareness of cyber safety concerns at school. On reflection, this item was not as closely related to the other measurement items as we originally thought and therefore was dropped before the structural model was calculated.

Table 2 shows that the verification of the discriminant validity requirement was met using the square root of the average (AVE) where the squared root of the average variance extracted for each construct is higher than the correlations between it and all other constructs. The constructs in the model have acceptable discriminant validity because the square root of the AVE is larger than its correlation with the other constructs (Gefen, Straub & Boudreau, 2000).

	A	**BI**	**C**	**FC**	**LA**	**PBC**	**PEOU**	**PGI**	**PI**	**PU**	**SE**	**SN**	**TI**
A	**0.900**												
BI	0.690	**0.930**											
C	0.886	0.665	**0.861**										
FC	0.518	0.565	0.500	**0.752**									
LA	0.699	0.615	0.710	0.622	**0.822**								
PBC	0.528	0.638	0.559	0.491	0.560	**0.801**							
PEOU	0.824	0.612	0.672	0.640	0.616	0.509	**0.786**						
PGI	0.463	0.512	0.537	0.476	0.462	0.387	0.419	**0.786**					
PI	0.519	0.371	0.553	0.366	0.529	0.406	0.431	0.459	**0.833**				
PU	0.779	0.578	0.805	0.391	0.686	0.479	0.554	0.452	0.598	**0.859**			
SE	0.570	0.584	0.567	0.547	0.657	0.615	0.521	0.403	0.348	0.541	**0.821**		
SN	0.507	0.486	0.583	0.452	0.506	0.428	0.416	0.635	0.592	0.551	0.399	**0.934**	
TI	0.281	0.294	0.381	0.384	0.337	0.243	0.337	0.551	0.446	0.281	0.229	0.528	**0.751**

Table 2. Correlations between constructs [Bold elements are square roots of AVE]

4.2 Structural Model and Tests of Hypotheses

Eight out of the twelve path coefficients are above 0.2 in both the original sample and the sample mean which indicates significance. Of the four that are below 0.2 all are still above 0.1 indicating marginal significance.

Figure 3 shows the original sample and the sample mean after bootstrapping. Almost all of the factors were significant in having a positive effect on behavioural intention, on the three antecedents of behavioural intention, attitude, subjective norm and perceived behavioural intention.

Subsequently, the individual factor loadings were evaluated for each of the measures of the research model. Each factor loading was greater than 0.5 which is considered practically significant (Hair et al., 2006). In addition, the majority of the reflective measures fulfilled the recommended level of composite reliability with a score greater than 0.7, apart from PEOU1 (0.657), PI3 (0.691), PG3 (0.662), TI3 (0.536) and FC3 (0.685). However, these are reasonably close to the 0.7 benchmark and deemed adequate.

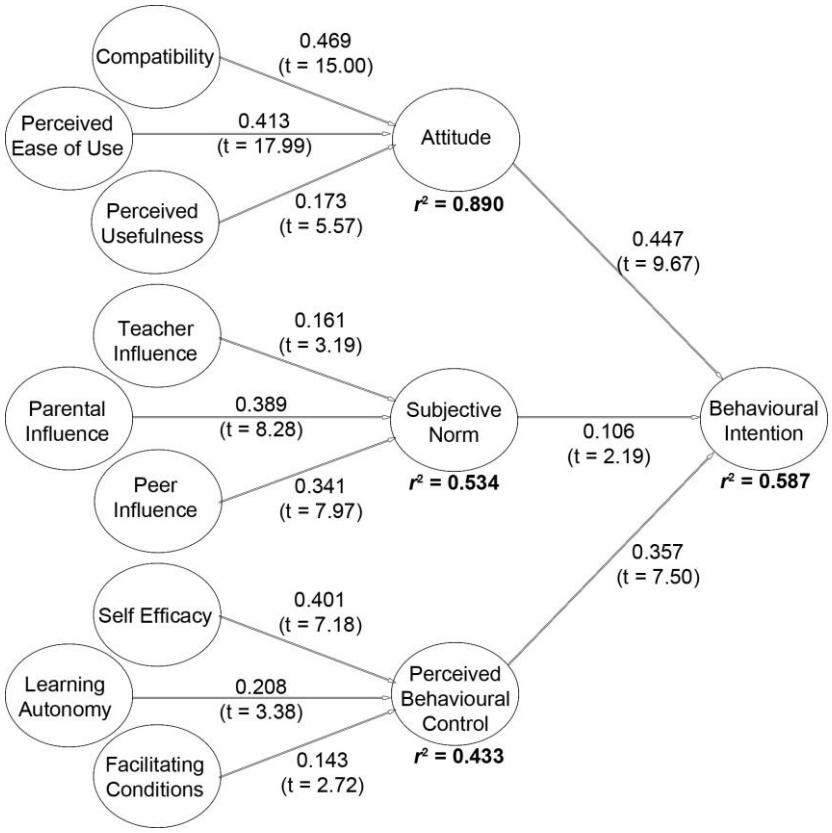


Figure 3 Structural Model of Behavioral Intention to BYOD by school students.

The structural model defines the causal relationship among constructs (Gefen, Straub & Boudreau, 2000). The structural model is assessed by path coefficients, t-values, and the variance explained (r^2) in the constructs. Figure 3 presents the standardized coefficients for each hypothesized path in the model and the r^2 for each of the endogenous latent variables. Two criteria were used to assess the quality of the structural model; First, the ability of the model to explain the variance in the dependent variables; Second, the statistical significance of the estimated model coefficients.

The r^2 of the structural equations for the dependent variables provides an estimate of the variance explained representing an indication of the success of the model in explaining these variables (Hair et al., 2006). The r^2 values of 0.67, 0.33, or 0.19 for endogenous latent variables in the inner path model are described as substantial, moderate, or weak by Chin (1998).

Given this, *Attitude* had an r^2 value of 0.890 which is substantial whilst *subjective norm* had an r^2 of 0.534, while *perceived behavioural control* had an R^2 of 0.433 and *behavioural intention* had an r^2 of 0.587, all of which are moderate. All of this means that *compatibility*, *perceived ease of use* and *perceived usefulness* explains 89.0% of the variance in attitude. *Teacher influence*, *peer influence* and *parent/guardian influence* explained 53.4% of the variance in subjective norm. *Self-efficacy*, *learning autonomy* and *facilitating conditions*

explained 43.3% of the variance in *perceived behavioural control*. In addition, *attitude, subjective norm* and *perceived behavioural control* explained 58.7% of the variance in *behavioural intention.*

5 Discussion

Students believed their device was easy to use while at school and it was easy to complete learning tasks on their device. On top of that, students perceived their devices to be useful based on beliefs that their device would: make learning easier; help them achieve better grades; and offer advantages that outweighed any disadvantages. Compatibility resulted in the strongest relationship with attitude. Not only did students believe that using their own device at school suited how they learn, and that the setup of their device was compatible with the way they learn, they also felt that using their own device fitted in with the overall learning style of the classroom.

Overall, students' attitudes towards using their own devices for learning were positive. The results show that attitude is the strongest predictor of students' behavioural intention. This is confirms the findings of with Taylor & Todd (1995). In terms of perceived ease of use, students typically believed instructions for using their own device at school were easy to follow.

In general, the extent to which teachers, parents or guardians and peers moderate students' social norms behaviour was fairly similar. Teachers however, had a slightly weaker relationship compared to the other referent groups. This finding implies that students are less concerned about their teacher's opinion than that of their peers or parents/guardians. From this, it can be seen that students will be more willing to adopt BYOD if they are surrounded by people who have already adopted BYOD, or who are positive about their intent to use BYOD.

Perceived behavioural control is an important construct in the context of students bringing their own device into the classroom. This is because even if users have a strong intention to perform this behaviour, they may lack the necessary resources and skills to do so (Taylor & Todd, 1995; Ajzen, 1991). The ability of students to learn independently with their device and control the pace of their learning was characterised by learning autonomy. The findings emphasise the importance of the shift in teaching pedagogy from an "I teach" to "we learn", as the role students play in their own learning increases. Self-efficacy was found to have the strongest positive effect on perceived behavioural control. This indicates that students feel comfortable using their own device and can operate them with minimal assistance. However, this does not mean that training for students would not be useful or necessary.

Facilitating conditions had the lowest positive relationship with perceived behavioural control. However, tto some extent this is expected in our study, as schools needed to have an minimal level of infrastructure suport in order to participate in the study. This finding differs from that of Taylor and Todd (1995) who found facilitating conditions to have a negative relationship with behavioural control. Schools should still be alert to possible barriers to use, such as: Wi-Fi connectivity, compatibility of learning content with the students' devices and issues of cyber safety.

The results of the study were able to explain 58.7% of the variance in behavioural intention. This is a similar figure to Taylor and Todd (1995) who found 60% variance in behavioural intention. Overall, our model has high explanatory power for students' intention to use BYOD for learning.

Eight out of the twelve path coefficients were above 0.2 in both the original sample and the sample mean which indicates significance. Of the four that were below 0.2 all were still above 0.1 indicating marginal significance. Students believed their device was easy to use while at school and it was easy to complete learning tasks on their device. This was based on beliefs that their device would make learning easier, help them achieve better grades, and that

the advantages of using their own device would outweigh any disadvantages. Students also felt that using their own device fitted in with the overall learning style of the classroom.

Attitudes among students towards using their own devices for learning were generally positive. The results show that attitude is the strongest predictor of students' behavioural intention. Taylor & Todd (1995) also found attitude to be the strongest predictor of students' behavioural intention, albeit in a different setting. Students were receptive to the idea of using their own device and believed that it was a good idea. Another insight for educators is that school supplied devices conversely may *not* align with what students think they need. It is likely students will want to use their own devices in preference to school supplied equipment. This suggests that schools should concentrate their technology investments on providing adequate infrastructure to support BYOD, and offering assistance to needy students to mitigate digital divide issues; rather than attempting to deliver standardised technology capabilities and solutions for students.

6 Conclusion

This study has successfully identified factors that affect the intent to use BYOD from the perspective of 21st century secondary school students in New Zealand. Although the study was conducted in New Zealand, the learning context is substantially similar to many other OECD and other English-speaking countries and there is no reason to expect a large variation in the results if the study were to be replicated in other national contexts. The results also suggest that devices that are easier to use and are compatible with the learning tasks at hand will positively affect students' intention to use and that the influence of peers, teachers and parents/guardians is important.

The research has affirmed the validity of Taylor and Todd's (1995) D-TPB, contextualised it for BYOD, and extended it by adding learning autonomy as a factor that has enhanced the applicability of the theoretical model to explain behavioural intention in an educational context.

To increase a student's perception of behavioural control, schools need to consider initiatives such as training sessions for students on how to use their device, taking precautionary measures such as cyber safety, as well as providing a sufficient network infrastructure.

The results explain 58.7% of the variance in students' behavioural intention to use their own devices for learning purposes. BYOD is still at an early stage of adoption and is likely to become more ubiquitous. Our study supports the efficacy of the decomposed TPB model for predicting adoption; suggests that many of the insights from previous "e" and "m" learning studies can be applied to BYOD; and offers some practical insights for institutions considering moving to BYOD.

Overall, this offers practical insight into BYOD and can be used as the basis of recommendations for schools, parents, and government. In particular, developing a flexible and adaptable BYOD strategy and infrastructure, in consultation with their community of students, teachers and parents may be preferable to providing standardised technology solutions. However, this has further policy implications including training, digital divide, responsibility for loss and damage, and security

New opportunities are now arising to build capability among teachers and students on how to incorporate and use BYOD into learning and pedagogy, done in collaboration with parents to promote the benefits of BYOD as an effective educational technology option. This research has laid some of the groundwork for the understanding required to design these initiatives.

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Appendix A - Survey Instrument

Attitude	A1	Using my own device at my school is a… • Bad idea • Good idea
	A2	Overall, I…. • Dislike the idea of using my own device • Like the idea of using my own device
Perceived Usefulness	PU1	Using my device makes my learning easier
	PU2	Using my device will help me get better grades
	PU3	The advantages of using my own device outweigh the disadvantages
Perceived Ease of Use	PEOU1	The schools instructions for using my own device at school are easy to follow
	PEOU2	My device is easy to use while at school
	PEOU3	It is easy to complete my learning tasks on my device
Compatibility	C1	Using my own device at school suits how I learn
	C2	Using my own device fits into the classroom learning style
	C3	The setup of my device is compatible with the way I learn
Subjective Norm	SN1	People who influence my behaviour think that I should use my own device to learn
	SN2	People who are important to me think that I should use my own device to learn
Peer Influence	PI1	Most of my friends think using a device to learn with is important
	PI2	Most of my classmates think using a device to learn with is important
	PI3	Generally speaking, I want to do what my friends think I should do
Teacher Influence	TI1	Most of my teachers encourage me to learn with my own device
	TI2	I have to use my own device when my teachers require me to
	TI3	Generally speaking, I want to do what my teachers think I should do
Parent/guardian Influence	PG1	My parents/guardian think I should use my own device at school
	PG2	My parents/guardian are happy with me taking my device to school
	PG3	Generally speaking, I want to do what my parents/guardian think I should do
Perceived Behavioral Control	PBC1	I can use my own device whenever I want
	PBC2	I can choose when I want to learn with my device
	PBC3	I have the skills and the ability to make use of my device
Self-Efficacy	SE1	I feel comfortable using my own device at school
	SE2	I can operate my own device on my own without any help at school
	SE3	It's up to me to learn in my own way with my device
Learning Autonomy	LA1	Using my own device allows me to learn independently
	LA2	Having my own device helps me to control the pace of learning in my class
	LA3	I can actively access coursework material with my own device
Facilitating Conditions	FC1	I can easily connect to the WiFi at school to get the internet access I need to support my learning
	FC2	My device has compatible applications (apps) and software to complete learning tasks
	FC3	When using my own device I am aware of cyber safety concerns at school
	FC4	I am worried about my device getting lost/stolen/broken whilst at school
Behavioral Intention	BI1	I intend to continue using my own device to learn
	BI2	I intend to use my own device for tasks set in the classroom by my teacher
	BI3	I intend to use my own device frequently this term

Table 3. Survey Instrument